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The Importance of DNA in America's Criminal Justice System

An Honor's Thesis (HONRS 499)

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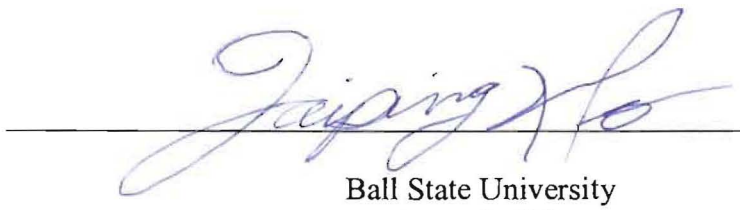

Ball State University
Muncie, IN

April 2008

Expected Date of Graduation: May 2008

Acknowledgements

I first and foremost want to thank Dr. Taiping Ho for not only being a wonderful, entertaining teacher, but also for guiding me through these last few years. I believe I would have been lost without you; thank you for your helpful advice and encouragement. I also wanted to thank my parents for understanding and allowing me to fall off the face of the earth for about a month so I could write this paper. I do appreciate your never-ending support. I also wanted to express my sincere gratitude to my best friend, Andrew Ardapple, who made me smile and laugh when I thought I would never finish this project; I do not think you will ever understand how much I appreciate the fact that you can ease the stress in my life. Last but not least, I want to thank Lindsay Leonhard for providing Dr. Ho with a hard copy of this paper while on was interning in Washington, D.C. Both you and Andrew are good friends. I do not think I could have made it through this journey without either one of you.

Abstract

DNA has garnered much media attention over the years, from the creation of television shows based on crime scene investigation to the broadcasting of several high profile murder cases. Yet, there is still some confusion on what this molecule is and how it can have such a powerful impact in the courtroom. This paper aims to provide both a clear understanding of DNA and an explanation of DNA analysis techniques as well as further exploration on how this substance has influenced court cases from the past to the present.

The Importance of DNA in America's Criminal Justice System

Introduction

On December 21, 2001, Larry Mayes felt the sun's warmth on his face as he walked out of the prison's gates ("DNA frees 100th," 2002). After 21 years of incarceration at the Indiana State Prison in Michigan City, IN, Mayes was finally a free man (*Innocence project*, 2007). Contrary to many assumptions, he was not out on parole; instead, he had been completely exonerated of a crime he was convicted of committing over twenty years earlier. Mayes's complete exoneration was in part thanks to DNA testing.

Mayes's life changed over two decades ago; in October of 1980, a woman was working at a gas station in Hammond, IN when two African American males entered into the establishment (*Innocence project*, 2007). One of the men pulled out a gun, demanded money, and took the woman captive. She was beaten with the butt of the gun and forced to perform oral and vaginal sex on both men. After the rape, she was dropped off where she immediately contacted police; she was subsequently taken to the hospital where a rape kit was performed.

Swabs from the victim's rape kit indicated the presence of semen, but serology tests did not yield conclusive results (*Innocence project*, 2007). Even though none of the fingerprints could be matched to Mayes and the victim was unable to choose him from a line up, the prosecution went forward with its case, because the victim was able to pick Mayes's picture out of an assortment of photos; the victim distinctly remembered that one of her assailants had a gold tooth and, therefore, she identified him by this trademark. Based only on the photo identification, Mayes was convicted on July 8, 1982, of rape, unlawful deviate conduct, and robbery (*Innocence project*, 2007). His punishment was 80 years in prison (*Innocence project*, 2007).

In 1996, Mayes was given some hope for a future filled with freedom; the Innocence Project, a non-profit legal clinic that works to exonerate the wrongfully convicted through DNA testing, decided to work on Mayes's case (*About the innocence*, 2007). Together, with the Indiana School of Law, it was discovered that the rape kit used at the trial had been lost; however, a thorough search of the evidence room in the courthouse revealed the missing rape kit (*Innocence project*, 2007). A motion was filed to have the evidence undergo DNA testing. Results excluded Mayes as the source of the sperm from the rape kit. DNA had set Mayes free.

Larry Mayes is not the only individual set free by DNA testing. Hundreds of wrongfully convicted individuals have been exonerated since this type of testing has become widely accepted and used ("DNA frees 100th," 2002). DNA testing has not only set the innocent free, but it also has turned the heat up on some cold cases by bringing assailants to justice after years of escaping the law. The purpose of this paper is to explain and elaborate on the importance of DNA in the criminal justice system. However, before discussing its impact, DNA should be first thoroughly examined.

Understanding DNA

Cells are the basic unit of life. Trillions of cells compose the human body, working together to complete daily bodily functions (National Center, 2004). However, just one cell is able to perform a variety of crucial activities. Each cell can take in nutrients, convert those nutrients into energy, carry out specialized functions, and reproduce if necessary (National Center, 2004). However, these specific activities cannot be completed without a certain set of instructions present in each cell. These instructions are known as deoxyribonucleic acid, which is more commonly known as DNA.

DNA is crucial to the human body. Specific locations along the DNA structure code for the production of certain proteins, which are responsible for carrying out most of the body's complex tasks (National Library, 2008). These specific locations are known as genes, which are hereditary plans responsible for manufacturing certain proteins and giving each human being a unique appearance (National Human, 2008). Yet, the entire DNA structure is a nucleic acid found in almost each and every cell of the human body, including muscle cells, brain cells, liver cells, and others. DNA is consistent throughout the body and does not change during a person's lifetime, meaning the DNA found in liver cells is going to be the same as DNA found in brain cells (Turman, 2001). Yet, there are a few cell types that do not contain this directive molecule. Red blood cells do not contain DNA; blood, however, can be typed by the DNA that is housed in the white blood cells (Riley, 2005).

Most DNA is housed in the nucleus of the cell; this type is known as nuclear DNA. Due to the fact that the nucleus is very small and has a limited amount space inside, the DNA molecule must be tightly packaged. DNA in this specific form is known as a chromosome. It is only forced out of this shape when the cell is preparing for duplication. DNA is also found in another cell structure known as the mitochondria, which is responsible for generating enough power for the cell to complete its specific tasks.

DNA itself is a long string-like structure composed of two lengthy strands of nucleotides. These nucleotides are the building blocks of DNA. One nucleotide contains three very important components: a nitrogenous base, a phosphate, and a deoxyribose sugar (Luftig & Richey, 2001). The phosphates and sugars bond in an alternating pattern, thus composing the backbone of one strand of the DNA molecule. However, each DNA molecule contains two of

these strands running in different directions and intertwining to create a double helix structure.

The interior structure of the DNA molecule is composed of the remaining nucleotide component: the nitrogenous bases. Each nucleotide contains one of the following four bases: adenine (A), thymine (T), cytosine (C), and guanine (G). Inside the DNA molecule, the bases pair up; hydrogen bonds glue A with T and C with G, thus stabilizing the entire DNA structure (Riley, 2005). Because of these specific base pairings, the double helix is also known as being complimentary. Figure 1 is a displays the structure of a DNA molecule.

Since water composes a large portion of the human body, adequate understanding of hydrostatic interactions is necessary in identifying the force holding DNA together. Because the sugar and phosphate groups are highly polar, the backbone that they create is also going to be polar, therefore making the exterior structure completely hydrophillic or attracted to water (Hughes, 2005). However, all four nitrogenous bases composing the inside of the structure are all nonpolar and therefore hydrophobic, meaning they are repelled by water (Hughes, 2005). This hydrophillic exterior and hydrophobic interior has a stabilizing effect on the entire double helix structure. The backbone works to protect the interior base pairings, keeping them in an ideal environment free from water. These forces keep the two strands together.

Yet, what is important is understanding the fact that two strands of alternating sugar and phosphate groups enclose complementary base pairings among the nitrogenous bases. Human DNA contains approximately three billion of these bases, and more than 99% of those bases are the same in all people (National Library, 2008). Yet, within the remaining 1% there are 13 DNA genetic markers that reveal nucleotide sequences unique to that person (Budowle, Chakraborty, Carmody, & Monson, 2000). These differing sequences provide enough variation among

individuals, but not enough to effect the function of the DNA or the proteins it encodes (Luftig & Richey, 2001). Essentially, each person's DNA is as unique as a fingerprint. Because no two people have the same genetic profile (with the exception of twins), DNA evidence collected from a crime scene can either link or eliminate specific individuals to that location.

The Three DNA Analysis Techniques

Restriction Fragment Length Polymorphism (RFLP)

There are three DNA analysis techniques available to compare DNA found at the crime scene to DNA taken from a specific individual of interest. Restriction Fragment Length Polymorphism (RFLP) is one of the earliest testing methods. There are 5 basic steps for this procedure. First, the DNA sample is digested by an enzyme called a restriction enzyme that cuts the DNA molecule at specific sites with a specific nucleotide sequence. Next, the DNA fragments are sorted by aragose gel eletrophoresis. Aragose gel electrophoresis is a procedure where all the fragments are placed in a gel and then an electric current is forced upon the gel (Riley, 2005). DNA molecules are negatively charged, so when the electric field is applied, the DNA migrates down the gel towards the positive anode. The smaller DNA fragments move faster than the larger ones and more easily through the gel matrix, so the fragments end up sorted by size (Riley, 2005). In the third step, a Southern blot is created. A replica of the gel is created in order to trap the fragments in their current positions. The blot is then treated with a probe, or a small nucleotide sequence, that binds to the DNA on the blot where it recognizes its complimentary sequences (Riley, 2005). In the fifth and final step, the blot is laid on x-ray film. The banding pattern is seen, revealing fragment sizes that are unique for each individual. These banding patterns can then be compared to another sample that has undergone the same procedure

using the exact same restriction enzymes. Figure 2 shows a Southern blot with visible band patterns.

RFLP was a groundbreaking procedure during its time of discovery in the 1980's (Turman, 2001). Yet, over the years, several drawbacks were revealed. RFLP is a very time-consuming process that requires a fairly large sample. Not only does this procedure require 100,000 or more cells initially, but it also requires that the sample be fresh and free from any degradation (Turman, 2001). If the DNA sample is old or already broken down into smaller fragments, this procedure will not produce accurate results. RFLP's reliability is again compromised if all steps are not controlled (Riley, 2005). Laboratory technicians must be very careful when completing each and every step. Finally, for accurate comparison among several individuals, an extensive database of profiles must be available (Riley 2005).

Polymerase Chain Reaction (PCR)

Yet, despite all of RFLP's drawbacks, it was still widely used until the early 1990's when another method was created: Polymerase Chain Reaction (PCR). PCR has three basic steps. First, the target DNA is heated in order to denature; the double helix structure is unwound (Powledge, n.d.). Next, the temperature is lowered and the primers are applied and bind themselves to the newly single strands of DNA. Primers are small sequences that are complimentary to the regions, flanking the DNA sequence of interest (Powledge, n.d.). Finally, polymerase, an enzyme, is added to facilitate DNA synthesis. DNA duplication occurs when the polymerase attaches itself to the region where the primer is attached (Powledge, n.d.). The enzyme reads the target sequence and sequentially adds bases to create a strand complimentary to the target strand. Two new helixes result, each composed of an original strand and a newly combined complementary

strand (Powledge, n.d.). This cycle of heating and cooling takes only one to three minutes, therefore, millions of copies of a single DNA strand can be generated within a very short time period (Powledge, n.d.).

PCR has shown to be truly beneficial over the years. It is much quicker than RFLP and can use a very small sample (Powledge, n.d.). PCR can also employ DNA that has experienced some degradation. This process can utilize old DNA, thus introducing new investigative leads in several cold cases.

Yet, this procedure is not completely foolproof. It does not filter contaminated original samples and, therefore, will duplicate tainted DNA. Numerous copies of irrelevant DNA will then be produced, possibly leading to some erroneous conclusions (Powledge, n.d). These incorrect assumptions could negatively effect an innocent person's life that lies in limbo.

Short Tandem Repeat (STR)

The final DNA analysis technique to be discussed is called Short Tandem Repeat (STR). STR is "the type of DNA used in most of the currently popular forensic DNA tests" (Riley, 2005, p. 8). It is basically the examination of repeating DNA sequences at 13 specific sites on the molecules (Turman, 2001). These 13 locations are the genetic markers that are responsible for creating distinction among individuals (Turman, 2001); therefore, these sites allow for human identity testing. People vary in the number of repeats they have at these specific sites. For example, DNA taken from one person may have a sequence at a particular location of CGCGCG whereas another person may have the sequence of CGCGCGCGCGCGCG at the same exact site (Riley, 2005). These distinct differences allow DNA evidence from a crime scene to be compared to a DNA sample provided by a suspect. For forensic purposes, PCR is often used to

amplify or generate many copies of a specific area of a DNA molecule where STRs can be analyzed. A suspect DNA sample could reveal a sequence of ATATATATATAT at a particular location while the DNA extracted from the crime scene revealed the same sequence at the same specific location, indicating a match (Riley, 2005). The more matches of sequences discovered at the same particular sites, the more confident scientists can be in concluding the suspect was the source of the DNA found at the crime scene.

However, the STR process is only as reliable as the initial DNA amplifying PCR procedure. Therefore, it is extremely important that laboratories take certain precautions in preventing already amplified DNA from mixing with samples that have not been tested yet. However, laboratories are not the only agencies that should take certain safety measures; law enforcement agencies need to as well. Contamination prevention begins at the crime scene.

Contamination Issues

As stated previously, DNA is present in nearly every cell of the human body; therefore, the assailant is bound to leave a part of himself behind at the crime scene. However, most biological evidence is invisible to the naked eye. The smallest most miniscule object could contain valuable DNA evidence. Therefore, investigators need to take several precautionary measures in order to preserve the proper testing of the evidence.

There are several sources of DNA: blood, sweat, semen, hair, saliva, ear wax, dandruff, and even mucous ("DNA evidence," 2003). Any of these biological fluids could point towards the guilty party. Therefore, anything and everything at the crime scene must be examined. Sweat or dandruff from a hat or mask needs to be analyzed. DNA could be extracted from blood found on a baseball bat. Saliva from an envelope, a glass, or a used cigarette could reveal the genetic

profile of the assailant. DNA could also be extracted from a used condom found on the floor of the crime scene. These are just a few of the many objects that should be analyzed for DNA.

However, genuine testing results that can be supported in court will not be obtained if the investigators do not take certain precautionary measures to protect the DNA evidence from being tainted. First and foremost, the first person that arrives on the crime scene must secure the area ("DNA evidence," 2003). Every safeguard must be taken to prevent any unauthorized law enforcement personnel and/or animals from entering the crime scene and further disturbing the evidence that lays there. Upon arrival, investigators and other law enforcement officers need to wear disposable gloves when touching anything in the crime scene area. It is essential to avoid touching more than one evidential object while wearing the same pair of gloves; investigators should then change their gloves often in order to prevent the mixing of biological evidence ("DNA evidence," 2003).

It is also important that investigators prevent mixing of their own biological fluids with those present at the crime scene. Therefore, there should be no coughing, sneezing, drinking, eating, or talking over any pieces of potential evidence ("DNA evidence," 2003). Investigators should also avoid touching their face and or other parts of their body while working at the crime scene ("DNA evidence," 2003). All precautions should be taken to avoid mixing investigator DNA with DNA evidence at the crime scene. Not only would this compromise testing results, but it would also allow investigators to be challenged on their evidence-collecting techniques, therefore, jeopardizing the entire investigation.

Objects containing potential DNA evidence should not be moved. Relocation of such evidence should only be permitted when there is a great risk of it being lost or destroyed ("DNA

evidence," 2003). When packaging evidence in preparation for transportation, be sure that the evidence is dry and package all objects in paper bags or envelopes ("DNA evidence," 2003). Paper allows the evidence to breathe whereas plastic produces condensation and moisture, promoting bacterial growth. Bacteria, moisture, and heat all speed up the degradation process, thus compromising the accuracy of DNA testing results. Finally, it is crucial for officers to maintain an accurate chain of custody ("DNA evidence," 2003). How the evidence was handled, every place the evidence traveled, and who handled the evidence must be documented for court purposes. Every officer action at the crime scene must also be documented in order to curtail any future accusations of law enforcement officers planting evidence.

Investigators also need to be aware of potential DNA evidence on the victim's physical person. Bite marks, blood stains on clothes, and semen in the vagina are all potential sources of DNA pointing to the assailant ("DNA evidence," 2003). Therefore, officers need to explain to victims, especially victims of sexual assault, the significance of obtaining a sexual assault exam. Officers should also stress the importance of not changing or washing their clothes or showering their bodies. Bed linens, towels, pillow cases, and other garments used during the commission of the crime should not be washed either, because they, too, can yield potential DNA evidence (Turman, 2001). These should all be collected, properly bagged in paper, sealed, and correctly labeled. All evidence needs to be transported out of the sunlight and in such a manner where it is documented that the proper chain of custody was maintained. DNA has longevity as long as it is properly packed and stored. Each and every precautionary measure needs to be taken in order to ensure accurate testing results. The reliable reputation of the crime lab is crucial to the prosecution's case whenever biological evidence is involved.

Early Judicial Decisions on New Scientific Evidence Admissibility

In order to accurately understand the court admissibility of DNA evidence, several court cases must first be discussed in order to assess their impact in admitting new forms of scientific evidence to the courtroom. The first major case addressing new scientific evidence was *Frye v. United States* (1923). In *Frye*, the defendant was convicted of murder and subsequently appealed his case to the Court of Appeals in the District of Columbia; the basis of Frye's appeal was that the trial court was erroneous in refusing to allow the jury to consider the results of a deception test. However, the court reaffirmed the trial court's previous judgment and established the *Frye* standard that required new scientific procedures to have gained general acceptance in the scientific community before being admissible in a court of law. In other words, because the defendant's systolic blood pressure deception results, which are similar to polygraph results, had yet to prove their reliability in this specific field of interest, the trial court was not mistaken when refusing to admit these results as evidence at trial.

Exactly 50 years later, the *Frye* standard was challenged when U.S. Supreme Court reviewed *Daubert v. Merrell Dow Pharmaceuticals* (1993). In *Daubert*, petitioners Jason Daubert and Eric Schuller were suing Merrell Dow Pharmaceuticals Inc. in a California state court; the petitioners were claiming that their birth defects were the result of their mother's ingestion of a drug that was marketed by the company. Merrell moved the case to federal court and tried to show that a trial was not necessary since expert testimony revealed that after a extensive literature review, no published study could link this specific drug as the causation of the birth defects. However, the petitioners claimed that this drug can, indeed, cause such birth defects; they presented in vitro and in vivo animal studies, as well as various pharmalogical

studies indicating a link among the drug and certain deformations (*Daubert v. Merrell Dow Pharmaceuticals*, 1993). However, despite all the petitioner's evidence, the court was forced to agree with Merrell, since the petitioner's evidence and scientific methodologies presented had yet to be accepted in the scientific community. The Ninth Circuit court stated this reason once again when the petitioner's appealed against the federal trial's decision. The U.S. Supreme Court would have the final word.

Upon hearing the case, the U.S. Supreme Court agreed with the petitioners. Since the adoption of the Federal Rules of Evidence in 1975, the Frye standard is no longer applicable. The Federal Rules of Evidence are specific guidelines that govern the admittance of evidence at federal trial; its 11 lengthy articles and over 50 detailed rules state that evidence is only admissible if it is both reliable and will aid the judge or jury in rendering an accurate decision (*Federal rules of evidence*, 2006). Focusing on the case at hand, Rule 702 does not mention the requirement of general acceptance, but explicitly states that only a "witness qualified as an expert by knowledge, skill, experience, training, or education may testify thereto in the form of an opinion or otherwise" (*Federal rules of evidence*, 2006, p. 29). Thus, establishing the *Daubert* standard, judges have the right to determine the admissibility of all testimony (*Daubert v. Merrell Dow Pharmaceuticals*, 1993). Scientific expert testimony must be both relevant and reliable in order for it to be heard in the courtroom. The relevancy of testimony refers whether it is pertinent to the issue at hand; reliability refers to the fact that the expert's conclusions must be drawn from the use of the scientific method (*Daubert v. Merrell Dow Pharmaceuticals*, 1993).

Frye, the Federal Rules of Evidence, and *Daubert* are all important instances to be aware of, because they all have impacted the admissibility of DNA evidence in the courtroom. DNA

was not introduced at trial until 1987 when a conviction was obtained in an Orlando, Florida rape trial ("The DNA 'wars,'" 1996) . For the first time, the prosecution presented biological evidence linking Tommy Lee Andrews to the scene of the crime; the DNA extracted from a blood sample provided by Andrews matched semen found at the crime scene ("The DNA "'wars,'" 1996).

However, Florida was not the only state creating waves by introducing DNA evidence at trials. The West Virginia Supreme Court, for example, was the "first state high court to rule on the admissibility of DNA evidence" ("The DNA 'wars,'" 1996, p. 2). In *State v. Woodall*, the court allowed DNA testing by the defendant; yet, because his DNA tests were inconclusive, the court still convicted him on rape, kidnapping, and robbery charges ("The DNA 'wars,'" 1996). However, later DNA testing exculpated Woodall and he was eventually released from prison.

Spencer v. Commonwealth was one of the very first cases with DNA evidence that rendered both a guilty verdict and a death penalty punishment ("The DNA 'wars,'" 1996). Defendant Spencer was convicted of both rape and murder when his DNA matched the DNA that was extracted from semen found on several victims ("The DNA 'wars,'" 1996). When he appealed his case to a higher court, his conviction and punishment were reaffirmed on the basis that expert testimony could not be provided in questioning the acceptance of DNA testing in the scientific world.

DNA in the Courtroom Today

The O.J. Simpson Murder Trial

The cases discussed up to this point have garnered little media attention; however, unbeknownst to many, O.J. Simpson was about to alert the world of the power of DNA. The O.J. Simpson murder trial "brought DNA testing in criminal cases to public awareness" (Ramsland,

2007, p. 1). On the evening of June 12, 1994, investigators were called to 875 S. Bundy Dr. in Brentwood, CA (Fuhrman, 1997). What they found upon arriving was a very gruesome scene; two individuals, later identified to be Nicole Brown Simpson and Ronald Goldman, had been stabbed and slashed to death. Despite being divorced, investigators immediately contacted Nicole's ex-husband, O.J. Simpson and quickly made their way over to his residence for an interview. Upon speaking with Simpson, detectives noticed he had a cut on one of his fingers of his left hand; blood patterns at the crime scene indicated that the killer had cut his left hand and left a trail of blood down the walkway to the gate (Ramsland, 2007). Investigators also noted that they saw blood stains on the door of Simpson's white Ford Bronco (Ramsland, 2007).

While detectives spoke with Simpson, crime scene investigators were working to collect all the evidence at the crime scene. Several blood samples were collected that when tested, failed to match either of the victim's genetic types (Ramsland, 2007). Bloody footprints were also discovered, later revealed to be made by a rare and expensive man's shoe; Simpson wore this type of shoe in a size similar to those that made the footprints discovered at the scene (Ramsland, 2007). Adjacent to the bodies, a bloodstained black leather glove was found, containing fibers from Goldman's jeans (Ramsland, 2007). The glove's counterpart was found at Simpson's residence with Simpson's blood. Both the victims' and Simpson's blood found in both Simpson's car and house; a mixture of Simpson's and Goldman's blood was found on the console of Simpson's vehicle (Ramsland, 2007).

At the time of the trial, DNA testing was a fairly new process; the general public did not have a clear understanding of this procedure. It was even harder for the jury to comprehend the process when the prosecution was constantly using scientific jargon and throwing around

technical terms. They did not boil the procedure down to layman's terms, therefore, the prosecution presented their case in an unappealing manner to the jury. Despite the fact that three different crime labs were able to match the blood at the scene to Simpson's genetic profile, forensic criminalistics expert Dr. Henry Lee testified that the DNA test results were erroneous (Ramsland, 2007). He stated that problems with the way the blood samples were packaged created tainted results. The defense claimed that because of this, there is the possibility that the samples were switched. The prosecution's case took another blow when it was revealed that the samples sat in a truck for a time period, disrupting the precious chain of custody (Ramsland, 2007). The defense won another victory over the prosecution when cross-examining criminalist Dennis Fung. In Fung's testimony, he admitted that investigators made several mistakes that could have contaminated the evidence ("O.J. Simpson," 2004). He also revealed that Simpson's Bronco was not properly sealed off and that the evidence collected from the scene was placed in plastic, allowing bacteria to breed and potentially damage the sample ("O.J. Simpson," 2004). The defense also claimed that the crime scene investigation team also allowed a rookie to collect evidence, implying that this individual was more likely to make more mistakes than a seasoned, trained technician ("O.J. Simpson," 2004). Unfortunately, all these instances of potential evidence contamination created enough reasonable doubt for the jury to render a not guilty verdict and, in turn, set Simpson free forever.

The Danielle van Dam Murder Trial

Investigators have certainly taken note of the O.J. Simpson case and have learned from the mistakes made by their fellow investigators. As a result, DNA testing methods have improved immensely and have become more of a reliable source of evidence. These new and

improved techniques have, for example, aided in convicting David Westerfield in murdering Danielle van Dam.

Danielle van Dam was a bright, bubbly seven year old little girl that disappeared into the night on February 1, 2002, in Sabre Springs, California ("A 'little girl lost,'" 2002). Her parents, Damon and Brenda van Dam, realized that their daughter was missing the next morning when her mother went to wake Danielle for breakfast. Danielle's nude body was found approximately one month later about 25 miles away from her home; examinations concluded that she had been sexually assaulted ("A'little girl lost,'" 2002). Investigators later arrested the van Dam's neighbor, David Westerfield, for her murder.

Several pieces of evidence were presented at trial. The prosecution indicated that bleach and several traces of Danielle's hair was found in a garbage can in Westerfield's garage ("A'little girl lost,'" 2002). Other fibers and hairs from the victim were found on several pieces of clothing in the laundry room of Westerfield's house ("A'little girl lost,'" 2002). Danielle's hair and blood were found in his RV, the same RV he left in a day after Danielle's disappearance ("A'little girl lost,'" 2002). Not only did investigators find a handprint, later identified to be Danielle's, on the cabinet above the bed in the RV, but they also found that Westerfield had cleaned his bedding the same day he became a suspect ("A'little girl lost,'" 2002). The victim's blood was found on Westerfield's jacket and fibers found on Danielle's necklace matched the fibers found in Westerfield's laundry and bedding ("A'little girl lost,'" 2002).

All this physical evidence, combined with Westerfield's alibi of meandering aimlessly through the desert in his RV, was enough evidence for the jury to render a guilty verdict. Westerfield was subsequently sentenced to death ("A'little girl lost,'" 2002). The van Dam

murder case is a good example of nuclear DNA testing linking a suspect to the crime scene. However, nuclear DNA testing cannot always be performed, especially if the sample is extremely degraded or such a sample is not obtainable. Mitochondrial DNA testing can then be performed. As stated previously, DNA is not only present in the nucleus of the cell, but also the mitochondria, which is the powerhouse of the cell structure. Although not as precise as nuclear DNA testing, mitochondria DNA testing can show "statistical likelihood of identification" ("Laci judge," 2003, p.1). Because this type of DNA is provided only by the mother, links can be shown among mothers, children, and siblings. The murder of Laci Peterson and her unborn son Connor, would bring this type of testing to the forefront.

The Laci Peterson Murder Trial

Laci Peterson was a beautiful, young woman reported missing on December 24, 2003 ("From start," 2005) ; she was eight months pregnant at the time ("From start," 2005). Her husband, Scott Peterson, told investigators that the last time he saw his wife was earlier that morning as he was preparing to leave for a fishing trip; he stated that she was getting ready to walk the couple's dog around the neighborhood. Searches revealed very few clues relative to her disappearance. Numerous interviews were conducted; it was later discovered that Scott was not only having an affair, but he also just recently took out a $250,000 insurance policy on his wife ("From start," 2005). Not long after his wife's disappearance, Scott had expressed interest in selling his home and immediately sold Laci's car in order to pay for a new truck ("From start," 2005). Police immediately pinpointed Scott as the main suspect of the investigation.

On April 13, 2004, the body of a full term baby washed upon the shore of the San Francisco Bay ("From start," 2005). The next day, a badly decomposed body was found nearby;

it was later identified to be the remains of Laci Peterson. Both were discovered within three miles of the area where Scott told authorities where he was fishing ("From start," 2005). Scott was later arrested at a golf course; upon being taking into custody, it was immediately noted that Scott had dramatically changed his appearance. Not only had he grown a goatee, but he had also obviously dyed his hair another color and was also carrying a large amount of cash.

Although circumstantial, there were several damning pieces of evidence presented against Scott. In addition to finding a homemade anchor in his boat, investigators also found a hair in Scott's boat ("Laci judge," 2003). The hair underwent mitochondrial DNA testing and the results were compared to results obtained from hairs found in Laci's brush; the findings indicate the two were derived from the same source ("Laci judge," 2003). Prosecutors argue that these results put Laci in the boat; according to Laci's family, she was unaware that Scott had a boat ("Laci judge," 2003).

These specific pieces of evidence, in combination with others, was enough for a jury to convict Scott Peterson of murder. He is currently sitting on death row.

The "'CSI Effect'"

The Laci Peterson, O.J. Simpson, and Danielle van Dam cases are only three of the many highly publicized investigations highlighting the power of DNA testing. These types of cases have not only captured the attention of the nation, but also have garnered public acceptance of such testing measures. In fact, television shows depicting criminal investigations have been created in order to fulfill the public's boundless thirst for knowledge on this particular subject. "CSI-Crime Scene Investigation" and its spin-offs, as well as "Law and Order," are all examples emphasizing the public's interest in DNA. However, this intrigue has inadvertently affected

DNA's use in the real-life court room. Experts have identified this as the "'CSI effect'" (Lovgren, 2004, p. 1).

The "'CSI effect'" occurs when viewers expect the investigation process they see on television to be the same procedure that happens in real life (Lovgren, 2004, p. 1). However, this is not the case. DNA testing for example, occurs on television shows almost immediately, however, in real life investigations, such testing results take at least a week to obtain (Lovgren, 2004). Unlike the television dramas, agencies and forensic scientists both also do not have enough time to focus on one single investigation; their heavy workloads force them to work several cases simultaneously. Nonetheless, the fascination has continued to mount in this subject area. Forensic science programs are on the rise at universities across the United States ("'The CSI effect,'" 2005). These programs have also become quite competitive, attracting the "brightest students, though many come with unreasonable expectations" (Lovgren, 2004, p. 1). With more individuals seeking education in crime scene investigation, prosecutors are also facing greater pressure to present forensic evidence at trial. Many jurors "want a clear trail of evidence, or they won't vote 'guilty'" ("'The CSI effect,'" 2005, p. 1). Overall, it appears that the "'CSI Effect'" is a mixed blessing for real crime labs" (Lovgren, 2004, p.1).

Conclusion

It is easy to understand why DNA has gained the public's fascination; many are amazed that this tiny, microscopic substance is responsible for distinguishing humans from one another. Its unique nucleotide sequences determine many identifiable characteristics, including hair color, eye color, and height. This distinguishing factor, along with its abundance throughout the human body, are reasons why the American criminal justice system has embraced forensic science.

With RFLP, PCR, and STR analysis techniques, forensic scientists are able to compare biological evidence found at the crime scene with samples derived from potential suspects. Even though a match does not indicate full culpability, it does, however, place that individual at the scene of the crime, pointing investigators in the right direction. Yet, court cases have shown that DNA evidence is only as accurate as the method in which it was collected. When utilized correctly and appropriately, DNA testing can protect the innocent and bring offenders to justice. Yet, on the other hand, and perhaps more importantly, it provides hope for the hopeless. DNA testing not only allows victims to believe that justice will eventually be served, but, it also permits the wrongfully accused, like Larry Mayes, to hope that they, too, will once again feel the sun's warmth outside the prison gates.

References

A 'little girl lost' is found dead, allegedly killed by neighbor. (2002). *Court TV News*. Retrieved on March 1, 2008, from http://www.courttv.com/trials/westerfield/background_ctv.html

About the innocence project. (2007). Retrieved April 12, 2008, from http://www.innocentproject.org/about

Budowle, B., Chakraborty, R., Carmody, G., & Monson, K.L. (2000). Source attribution of a forensic DNA profile. *Forensic Science Communications, 3*. Retrieved March 1, 2008, from http://www.fbi.gov/hq/lab/fsc/backissu/july2000/source.htm

Daubert v. Merrell Dow Pharmaceuticals, 509 U.S. 579 (1993).

DNA evidence: What law enforcement officers should know. (2003). *The National Institute of Justice Journal*, 249, 10-15.

DNA frees 100th inmate as advocates call for movement to reform. (2002). *Court TV News*. Retrieved March 16, 2008, from http://www.courttv.com/archive/ news/2002/0118/DNA_ap.html

Federal rules of evidence. (2006). Retrieved March 8, 2008, from http://judiciary.house.gov/media/pdfs/printers/109th/31310.pdf

From start, suspicion falls on Peterson. (2005). *Court TV News*. Retrieved March 1, 2008, from http://www.courttv.com/trials/peterson/background.html

Frye v. United States, 293 F. 1013 (1923).

Fuhrman, M. (1997). Murder in Brentwood. Washington, D.C.: Regnery Publishing, Inc.

Hughes, A. (2005). *Primary DNA molecular structure*. Retrieved March, 8, 2008, from

http://cnx.org/content/m11411/latest/

Innocence project: Larry Mayes. (2007). Retrieved April 12, 2008, from http://www.innocentproject.org/Content/207.php.

Laci judge OKs DNA evidence. (2003). *CBS News*. Retrieved March 28, 2008, from http://www.cbsnews.com/stories/2003/11/18/national/main584190.shtml

Luftig, M. A., & Richey, S. (2001). DNA and forensic science. New England Law Review, 35, 609-613.

Lovgren, S. (2004). 'CSI Effect' is mixed blessing for real crime labs. *National Geographic News*. Retrieved February 14, 2008, from http://news.nationalgeographic.com/news/pf/80520796.html

National Center for Biotechnology Information. (2004). *What is a cell?*. Retrieved March, 8, 2008, from http://www.ncbi.nlm.nih.gov/About/primer/genetics_cell.html

National Human Genome Research Institute. (2008). *Deoxyribonucleic acid.* Retrieved March 10, 2008, from http://www.genome.gov/25520880#4

National Library of Medicine. (2008). *What is DNA?*. Retrieved March, 8, 2008, from http://ghr.nlm.nih.gov/handbook/basics/dna

Powledge, T. M. (n.d.). *The polymerase chain reaction*. Retrieved March 16, 2008, from http://opa.faseb.org/pdf/The%20Polymerase%20Chain%20Reaction.pdf

O.J. Simpson: Week-by-week. (2004). *Court TV*. Retrieved March 15, 2008, from http://www.courttv.com/trials/ojsimpson/weekly/11.html

Ramsland, K. (2007). *DNA and O.J.* Retrieved March 8, 2008, from http://www.crimelibrary.com/forensics/dna/

Riley, D. E. (2005). DNA testing: An introduction for non-scientists. *Scientific Testimony: An Online Journal.* Retrieved March 1, 2008, from http://www.scientific.org/tutorials/articles/riley/riley.html

'The CSI effect': Does the TV crime drama influence how jurors think?. (2005). *CBS News.* Retrieved February 14, 2008, from http://www.cbsnews.com/stories/2005/03/21/earlyshow/main681949.shtml

The DNA "wars" are over. (1996). Retrieved on March 16, 2008, from http://pbs.org/wgbh/pages/frontline/shows/case/revolution/wars.html

Turman, K. M. (2001). Understanding dna evidence: A guide for victim service providers. *Office for Victims of Crime (OVC) Bulletin*. Retrieved March 1, 2008, from http://www.ncjrs.gov/pdffiles1/nij/bc000657.pdf

Figure Caption

Figure 1. Model of the structure of a DNA molecule.

Figure 2. Photo of a Southern blot revealing an individual's descriptive bands patterns.

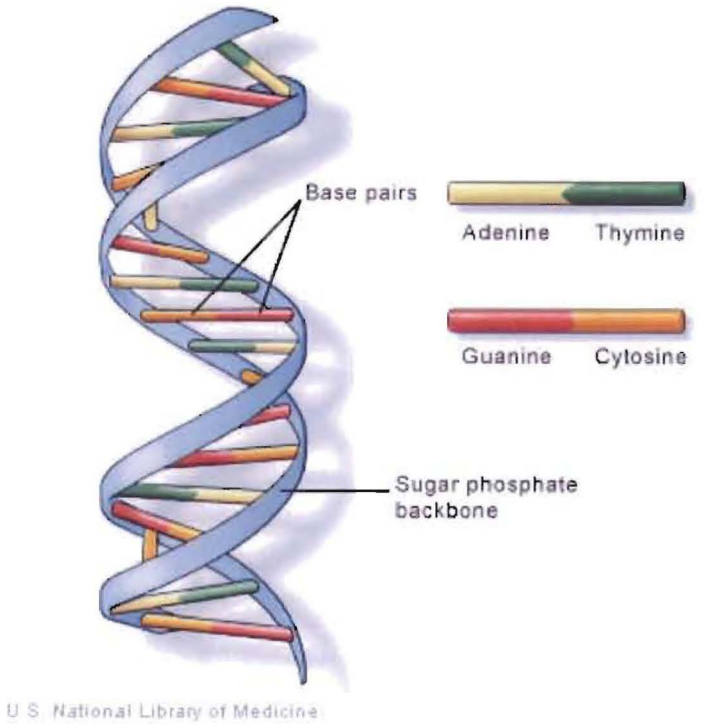

Figure 1.

Note. From "How Stuff Works" by U.S. National Library of Medicine. Retrieved March 8, 2008, from http://science.howstuffworks.com/dna1.htm. Copyright by U.S. National Library of Medicine. Reprinted with permission.

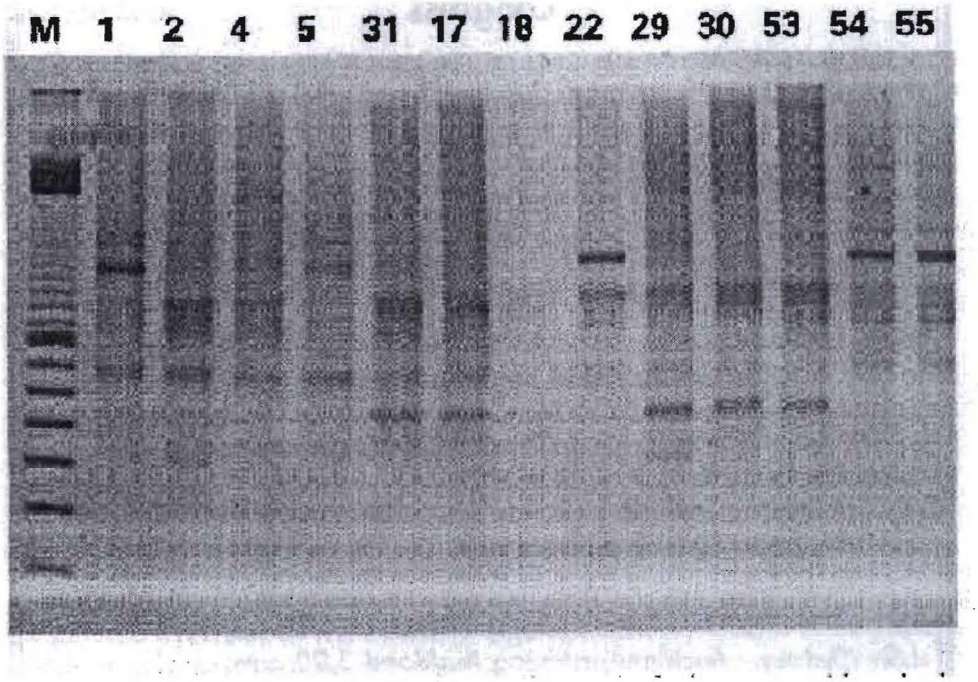

Figure 2.

Note. From "Dynamic DNA, The Big Molecule That Makes Us All." Retrieved March 1, 2008, from http://www.mathemagic.org/MOBM/DynamicDNA.html. Reprinted with permission.